Digital Airborne Scanner

3-DAS-1

User Manual

3-DAS-1-UM

Camera model	**3-DAS-1**
Manufacturer	**GeoSystem, 600-letia 25, Vinnitsa, 21027 Ukraine. www.vingeo.com**

«3-DAS-1» User Manual

General notes

Please read this manual carefully before you start working with any equipment of Digital Aerial Scanner 3-DAS-1.

Please do not remove and repair any scanner elements by yourself. This can cancel warranty.

Third-party brands and names are property of their respective owners.

Any dysfunctions of third-party components, which are parts of the system, are not described in this document. To remove such faults please refer to service center of corresponding manufacturer.

Due to rapid changes in technology some specifications might be out-of-date before publication of this manual.

Table of Content

Introduction

3-DAS-1 is a pushbroom airborne scanner designed for high resolution aerial survey with simultaneous image creation by three color channels. Nadir channel captures ground surface images just below the aircraft and is used for automated creation of orthophoto. Forward and backward channels capture images with 26º and 16º angles along the flight direction providing permanent triple overlap for whole area.

Scanner 3-DAS-1 allows you to increase productivity and accuracy of digital topographic maps based on aerial survey due to elimination of analogue photo processing and their conversion to digital form for sequential work on digital photogrammetric stations.

3-DAS-1 scanning system consists of 3-DAS-1 scanning unit, DAS Control Computer, RAID array and operator’s display. (Figure1).

Figure 1: Components of 3-DAS-1 scanning system.

Structure and principle of operation

The scanner is an airborne optic-electronic device designed to scan ground surface from an aircraft board for obtaining the digital images in real-time mode.

Composition:

- Scanner is a three-channel system, each channel of which contains light-sensitive CCD-sensor, optic-mechanical system, electronic system to control and signal conversion. (Figure 2)

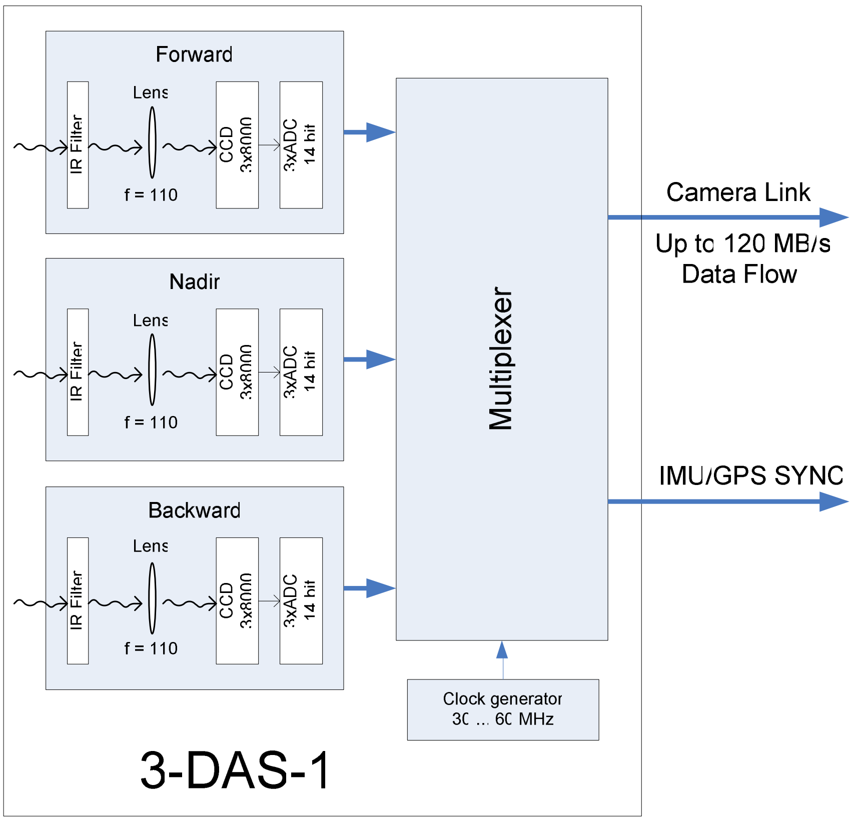


Figure 2: Flowchart of 3-DAS-1 scanner.

- Control computer receives image data from the scanner, preprocesses it and transfers it to RAID array. Also it is used to adjust, calibrate and control scanning modes.
- Operator's display shows scanned image in real-time mode and controls scanner adjustment, calibration and operation.

- RAID array is high-performance protected RAID array of huge capacity to gather image data during the flight mission and their transportation for processing to your office. (Figure 3)

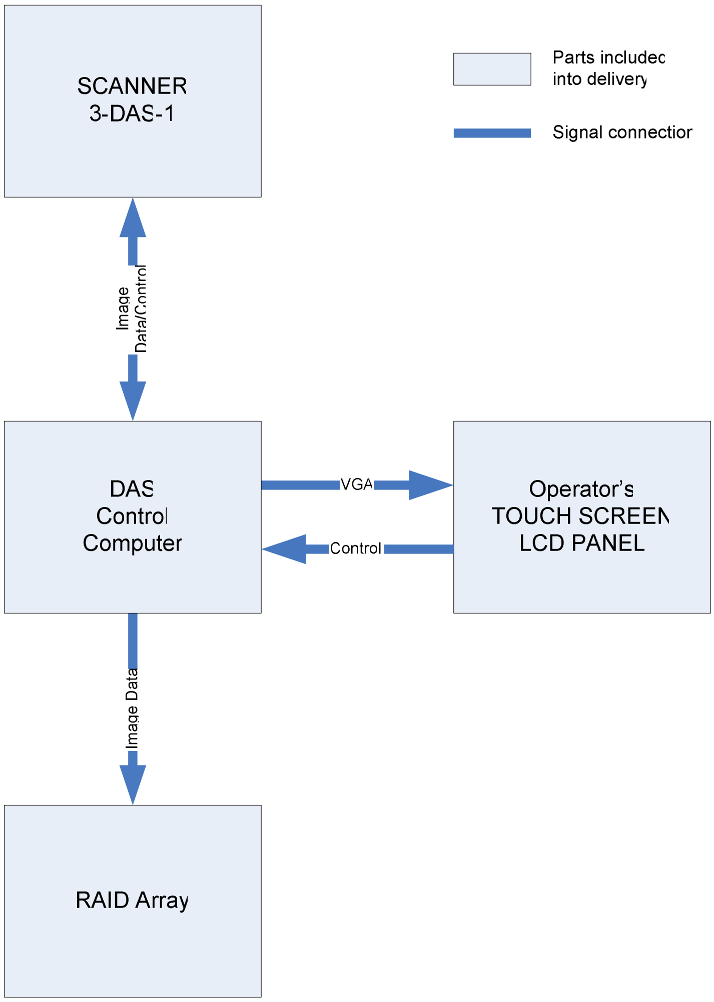


Figure 3: Flowchart of 3-DAS-1 scanning system.

Position and Orientation System (POS) like Applanix POS AV or IGI AEROcontrol also Flight Management System (FMS) like Applanix POSTrack or IGI CCNS4 and stabilized mount like ASP-1 or Leica PAV30 (for attitude stabilization) are required for normal operation of scanning system. (Figure 4)

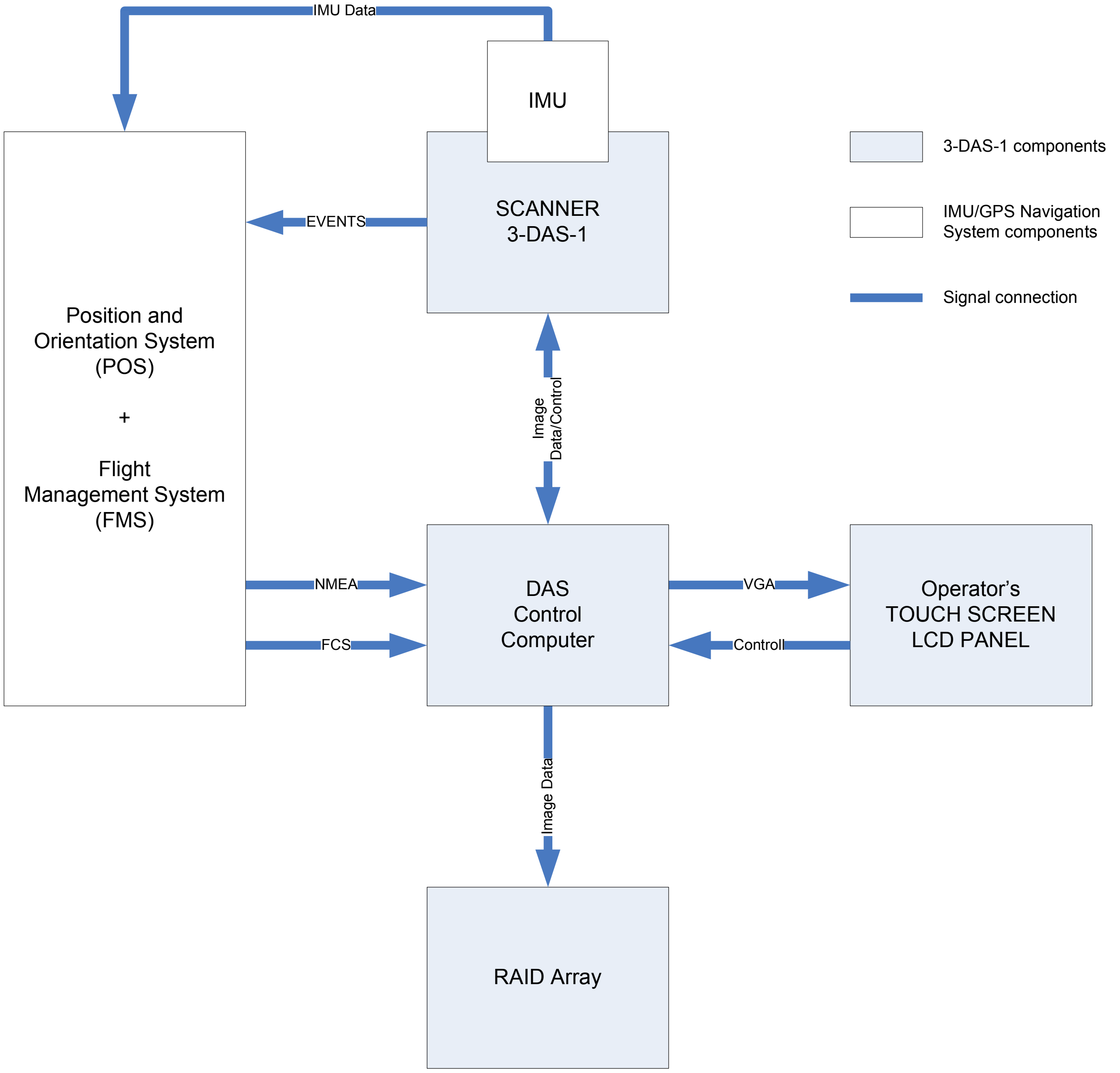


Figure 4: Flowchart of 3-DAS-1 scanning system including POS and FMS.

Part 1. 3-DAS-1 hardware description

1.1. Hardware installation

To install scanning system, please do the following:

- Step 1 – 3-DAS-1 scanner installation
- Step 2 – Control computer installation
- Step 3 – RAID-array installation
- Step 4 – Operator’s display installation
- Step 5 – General cabling and connection of board power
- Step 6 – Connection of Flight Management System laptop (optional)

Please disconnect power when cabling.

Step 1 – 3-DAS-1 scanner installation

Some elements of the scanner weigh more than 15 kg. Therefore at least 2 persons should install the system.

To avoid damaging of optical system please never put the scanner with its lenses down on soft surfaces.

Step 1-1: 3-DAS-1 to PAV30 adapter installation (Mass-compensator installation)

Adapter (Mass-compensator) is needed for stabilizing mount PAV30 usage.

- Mount mass-compensator housing on stabilized platform guiding by “Flight Direction” sign. Be sure that flanges on the moving ring coincide with slots on the mass-compensator housing. Fix it with four fixing screws. (Figure 1.1)

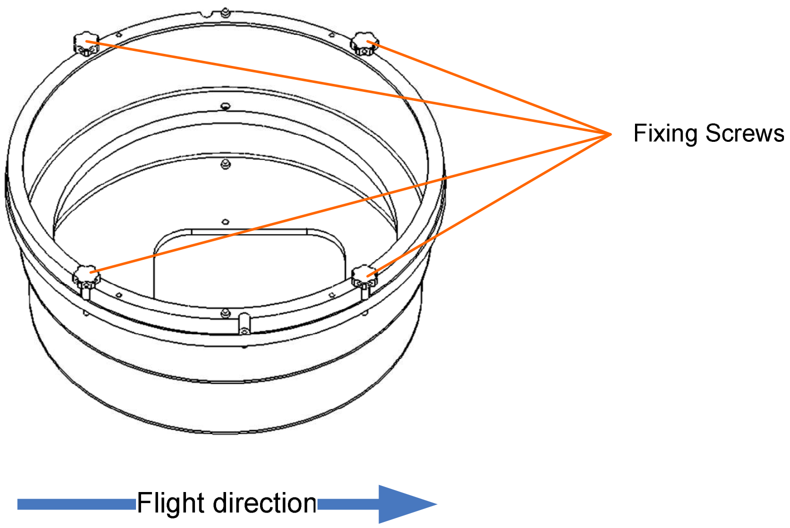


Figure 1.1: Mass-compensator housing.

- Put counterweights and top plate into the housing in sequence shown on figure 1.2.

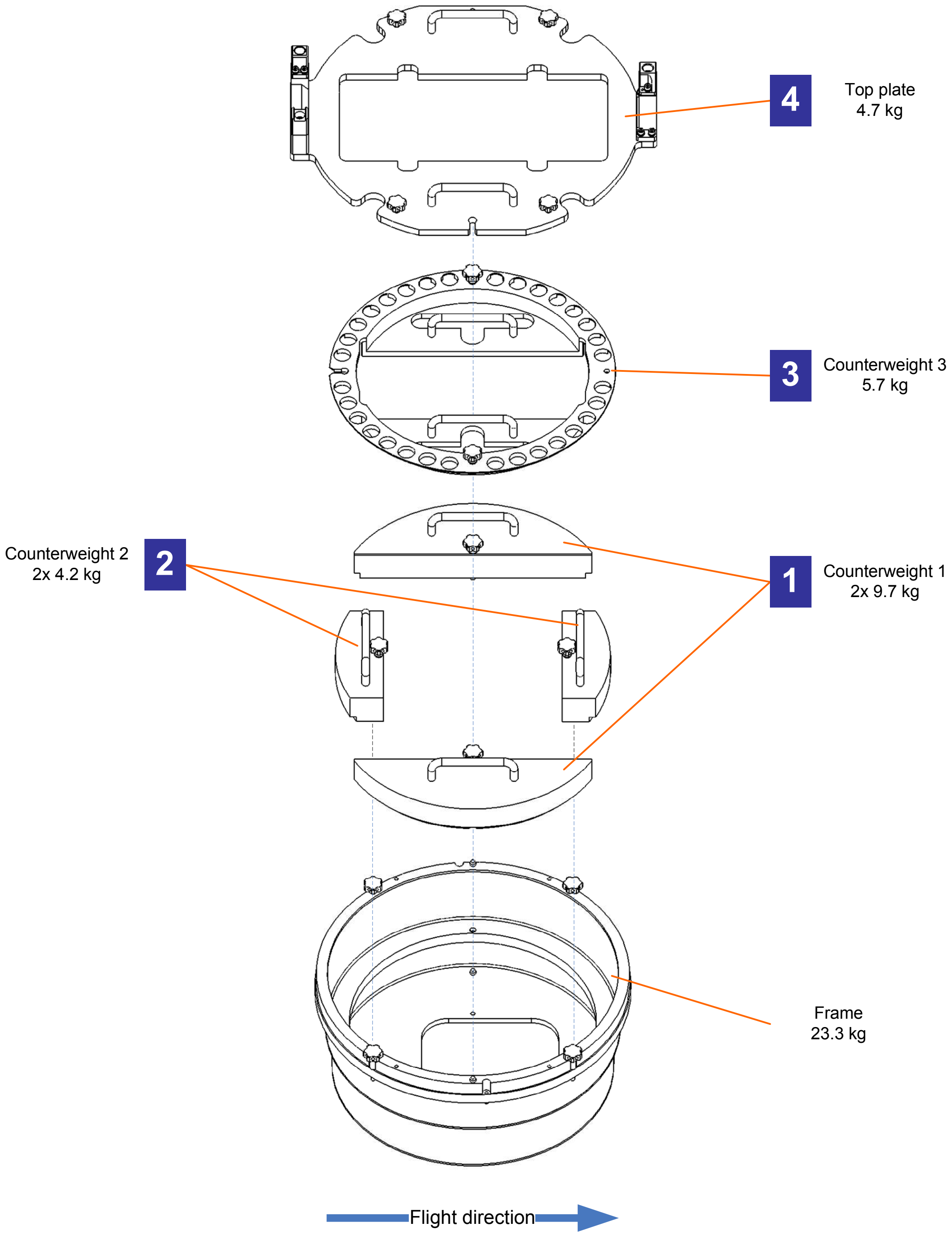


Figure 1.2: Sequence of mass-compensator assembly.

Be sure that all components of the mass-compensator are fastened with fixing screws securely.

Mass of assembled compensator is 61.4 kg.

Step 1-2: Scanner mounting on top of the mass-compensator

The scanner includes shock sensitive elements. Please perform all operations slowly and carefully.

- Mount 3-DAS-1 scanner on mass-compensator guiding by “Flight Direction” sign.
- Be sure that the scanner is in its unique position and fasten it with three fixing screws. (Figure 1.3)

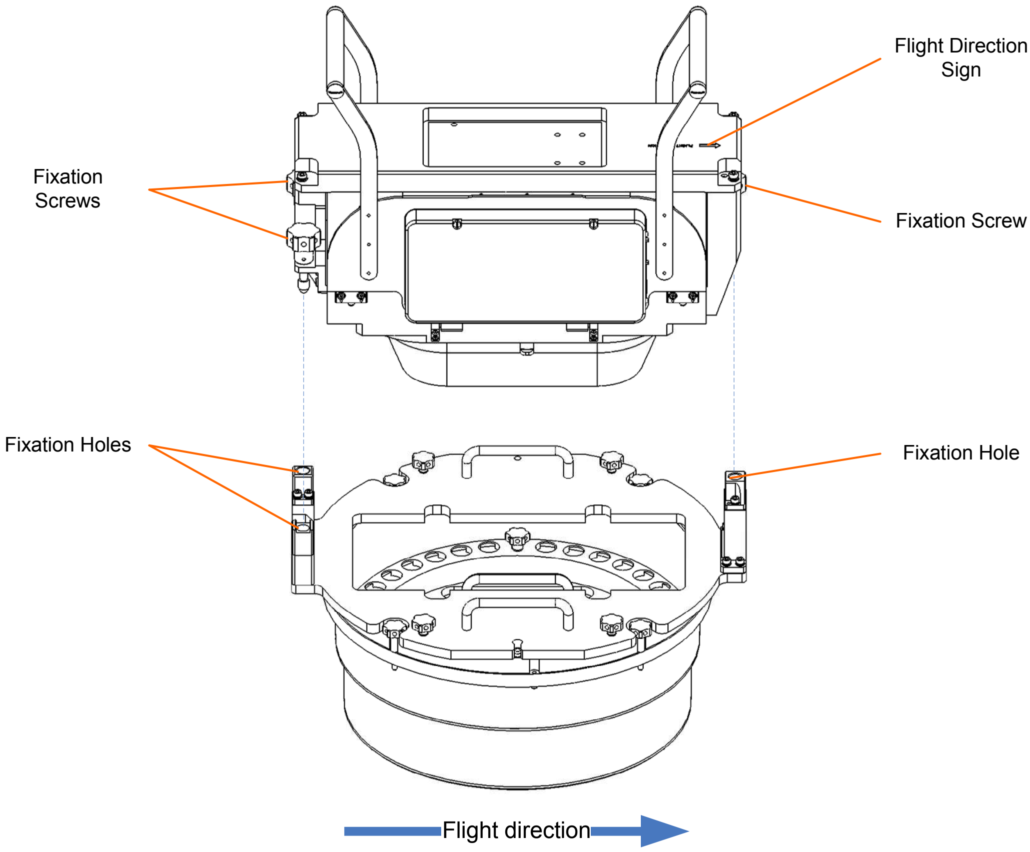


Figure 1.3: Mounting of the scanner on top of the mass-compensator.

Step 1-3: Inertial Measurement Unit (IMU) mounting on 3-DAS-1 scanner

Please avoid scratches on IMU adapter plate. It can cause changing of IMU position relative to scanner optical system.

Mount IMU on plate on top of the scanner as it's shown in figure 1.4.

- Remove IMU plate unscrewing four fixing screws.
- Mount IMU onto IMU plate guiding by "Flight Direction" sign.
- Mount IMU plate back on top of the scanner and fix it with four screws.

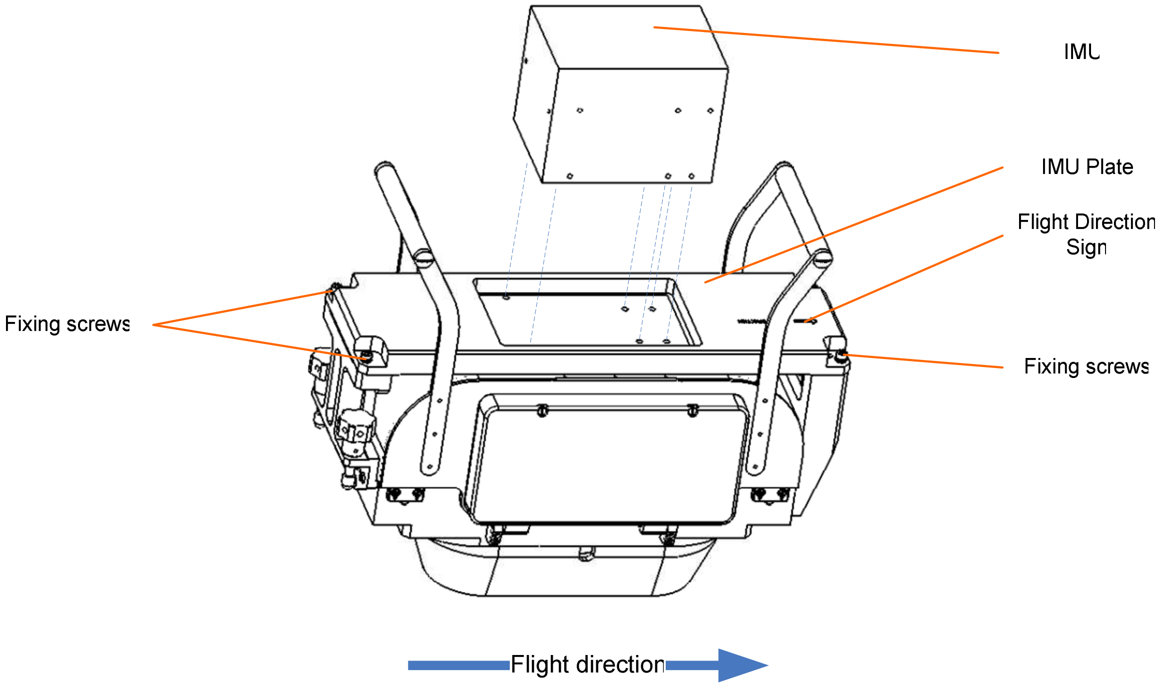


Figure 1.4: IMU mounting on 3-DAS-1.

IMU is not a product of SPE "Geosystem". Please refer to manufacturer to get installation manual.

Coordinates of IMU navigation center relative to the point of PAV30 platform axes intersection (when mass-compensator used) for several IMU models are given in table 1.1:

Table 1.1: Coordinates of IMU navigation center

Axis	**IGI** **IMU-IId, mm**	**Applanix LN200**	
		With case, mm	**Without case, mm**
X	0,15	-5,01	-5,01
Y	-16,20	-14,84	-14,84
Z	-337,90	-341,03	-334,03

Axes direction: X – forward, along flight direction;
Y – right;
Z – downward.

Step 2 – Control computer installation

Shocks and increased vibration can cause failure or its frozen-in damages. Please perform all operations slowly and carefully.

To install control computer on-board use rack with damping elements.

- Move out guides from the rack, coincide with guides on control computer case and move computer inside the rack up to the stop. (Figure 1.5)

Be careful during guide coincidence. Rough mounting can cause damage of guide bearings.

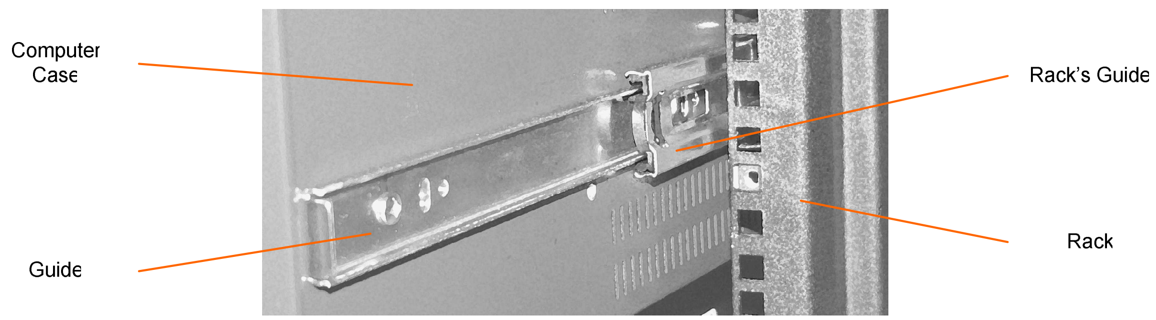


Figure 1.5: Guide of computer case.

- Fix computer inside the rack with four screws on front panel. (Figure 1.6)

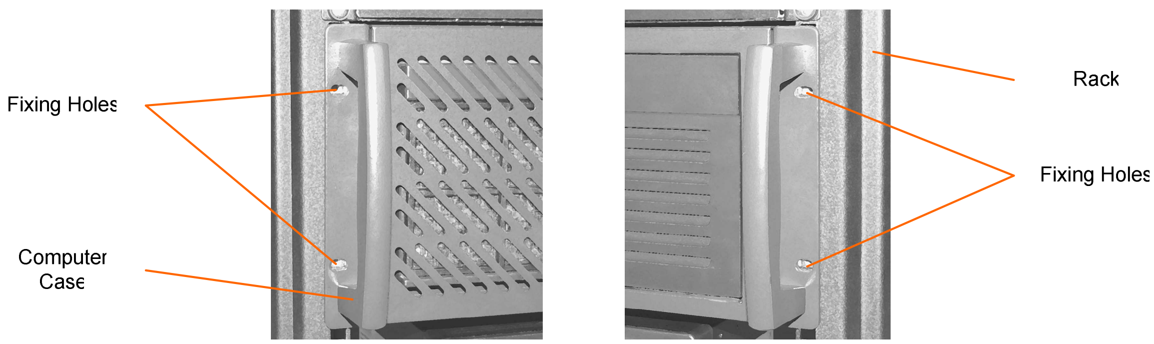


Figure 1.6: Fixing holes of computer case.

Step 3 – RAID-array installation

Shocks and increased vibration can cause failure or its frozen-in damages. Please perform all operations slowly and carefully.

To install RAID-array on-board use rack with damping elements.

- Unscrew two side fixers and move out in-out table from the rack.
- Place RAID-array onto the table, coincide with fixing holes and screw fixing screws. (Figure 1.7)

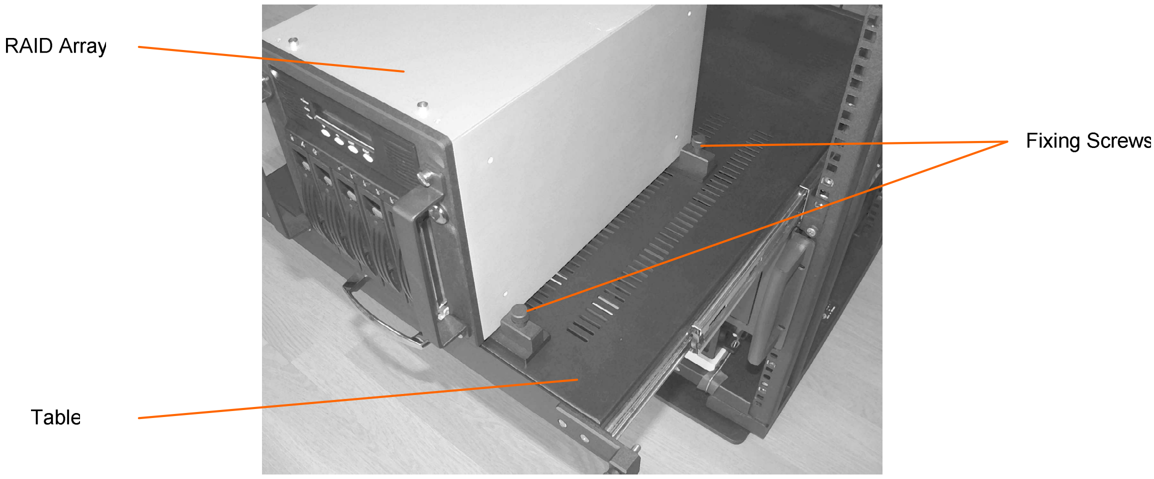


Figure 1.7: RAID-array mounting on in-out table of the rack.

- Move in-out table with RAID-array up to the stop and fix it with two side fixing screws. (Figure 1.8)

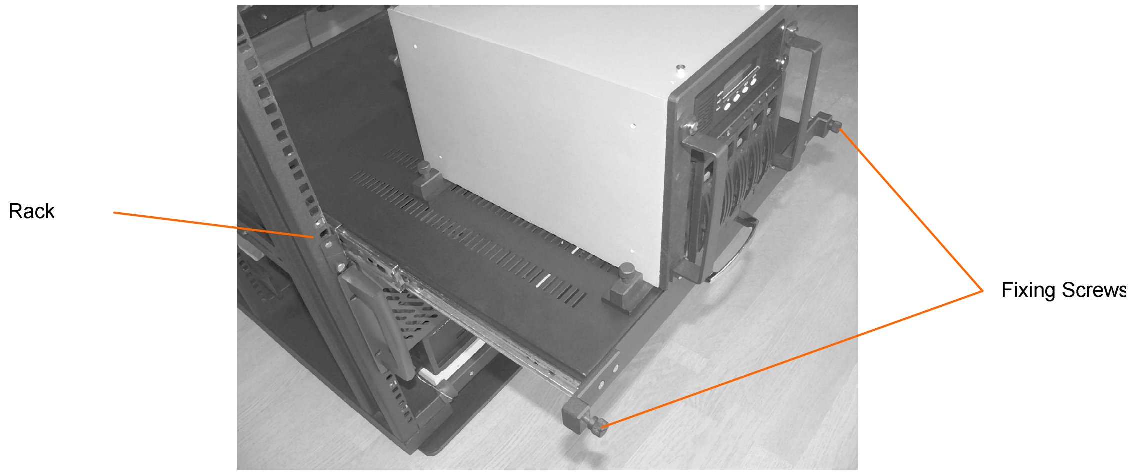


Figure 1.8: Fixing screws of the in-out table.

Step 4 – Operator's display installation

Operator's display is mounted to the rack with Velcro. To fix safely you should coincide display table with contours of rack upper part and push tightly.

Step 5 – General cabling and connection of board power

Flowchart of scanning system connections including POS AEROcontrol and FMS CCNS4 by IGI GmbH is shown in figure 1.9.

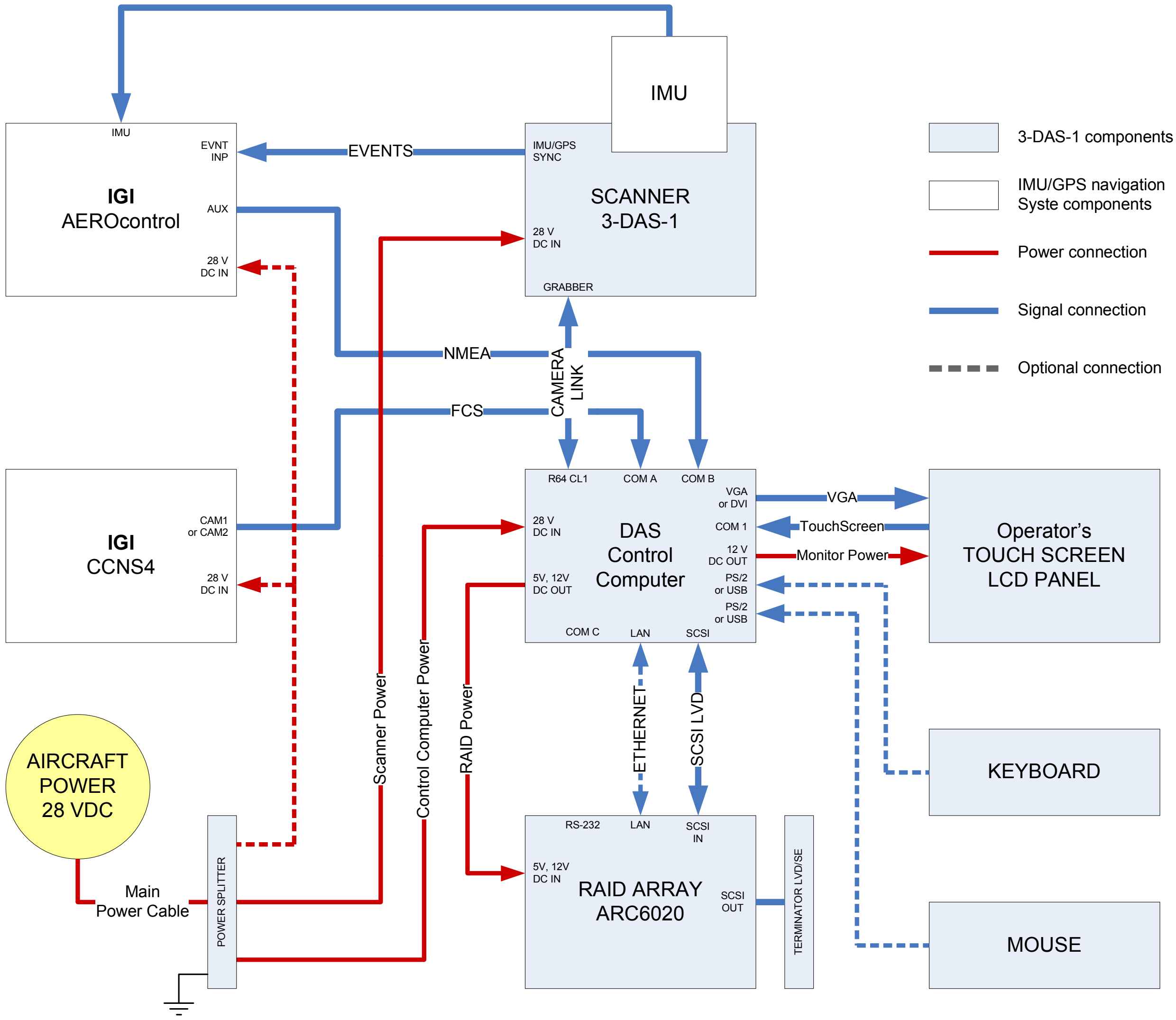


Figure 1.9: Flowchart of system connections.

Spare slot on power splitter is available to supply POS and FMS.

Please keep polarity during connection of board power. Otherwise it can cause partial or full system failure.

Check all connectors and cables in order to find damages before their connection.

Step 5-1: Connection of control computer

- Connect “COM A” port of control computer with CAM1 or CAM2 port of CCNS4 unit via FCS cable.
- Connect “COM B” port of control computer with AUX port of AEROcontrol unit via NMEA cable.
- Connect “Control Computer Power” cable to “28 V DC IN” input of the computer. (Figure 1.10)

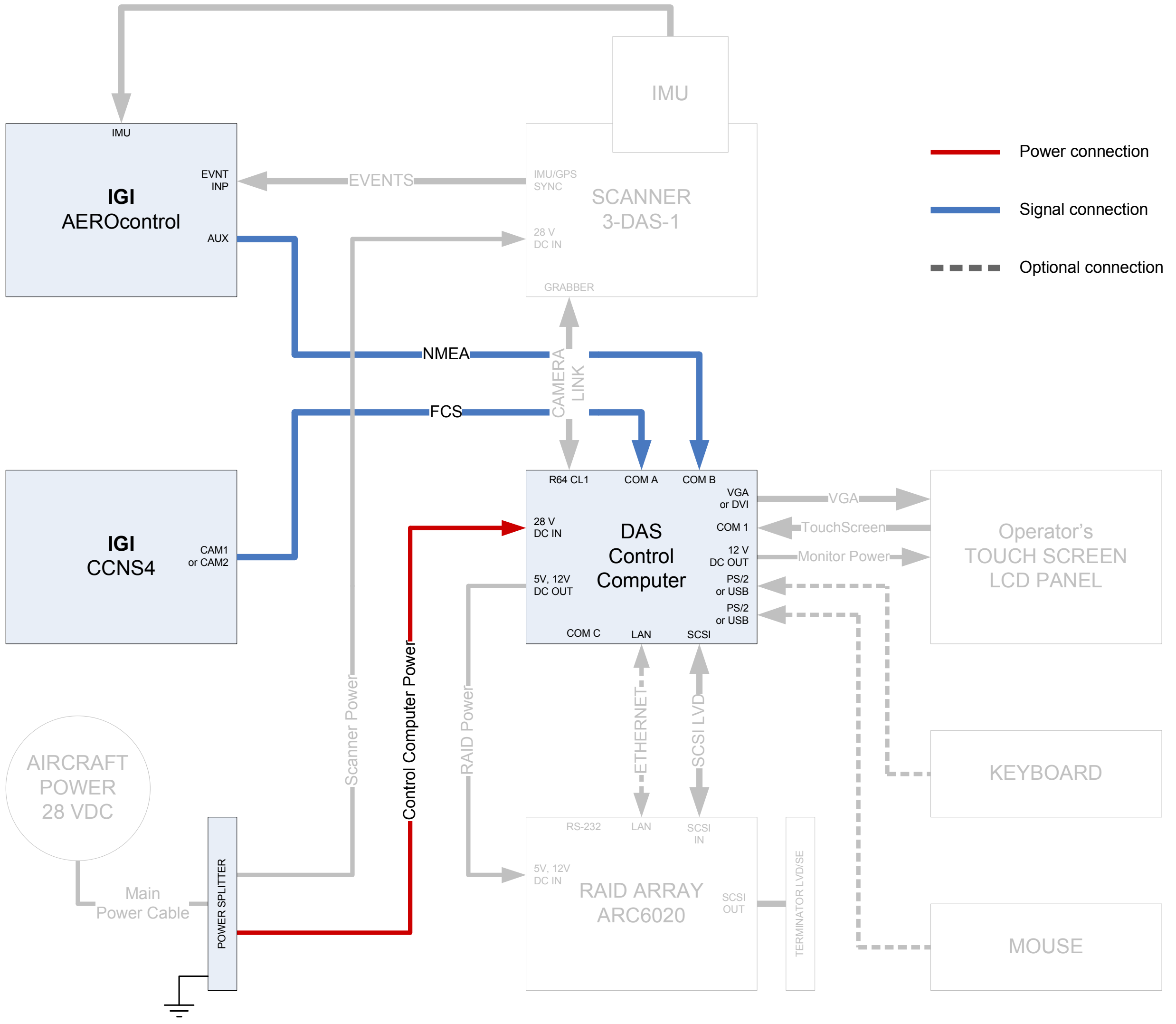


Figure 1.10: Connection of control computer.

General view of control computer back panel is shown in figure 1.11.

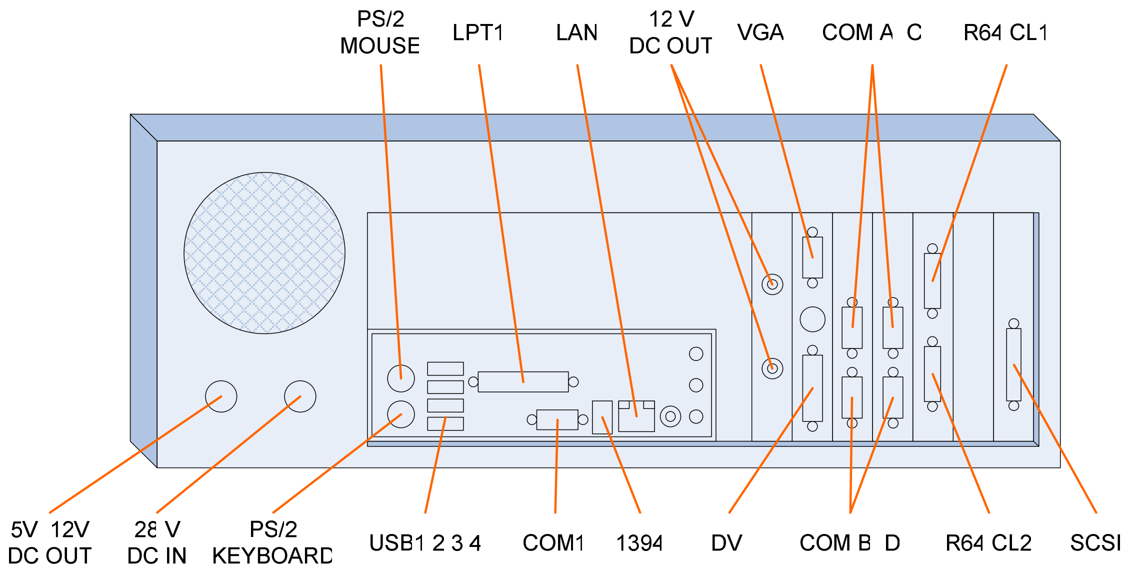


Figure 1.11: Control computer, back view.

Step 5-2: RAID-array connection

- Connect SCSI IN port of RAID-array ARC6020 with SCSI port of control computer via “SCSI LVD” cable.
- Connect LVD/SE terminator with SCSI OUT port of RAID-array.
- If configuration of RAID-array controller is required, connect RAID-array with control computer via “ETHERNET” cable.
- Connect “5V, 12V DC IN” input of RAID-array with “5V, 12V DC OUT” connector of control computer. (Figure 1.12)

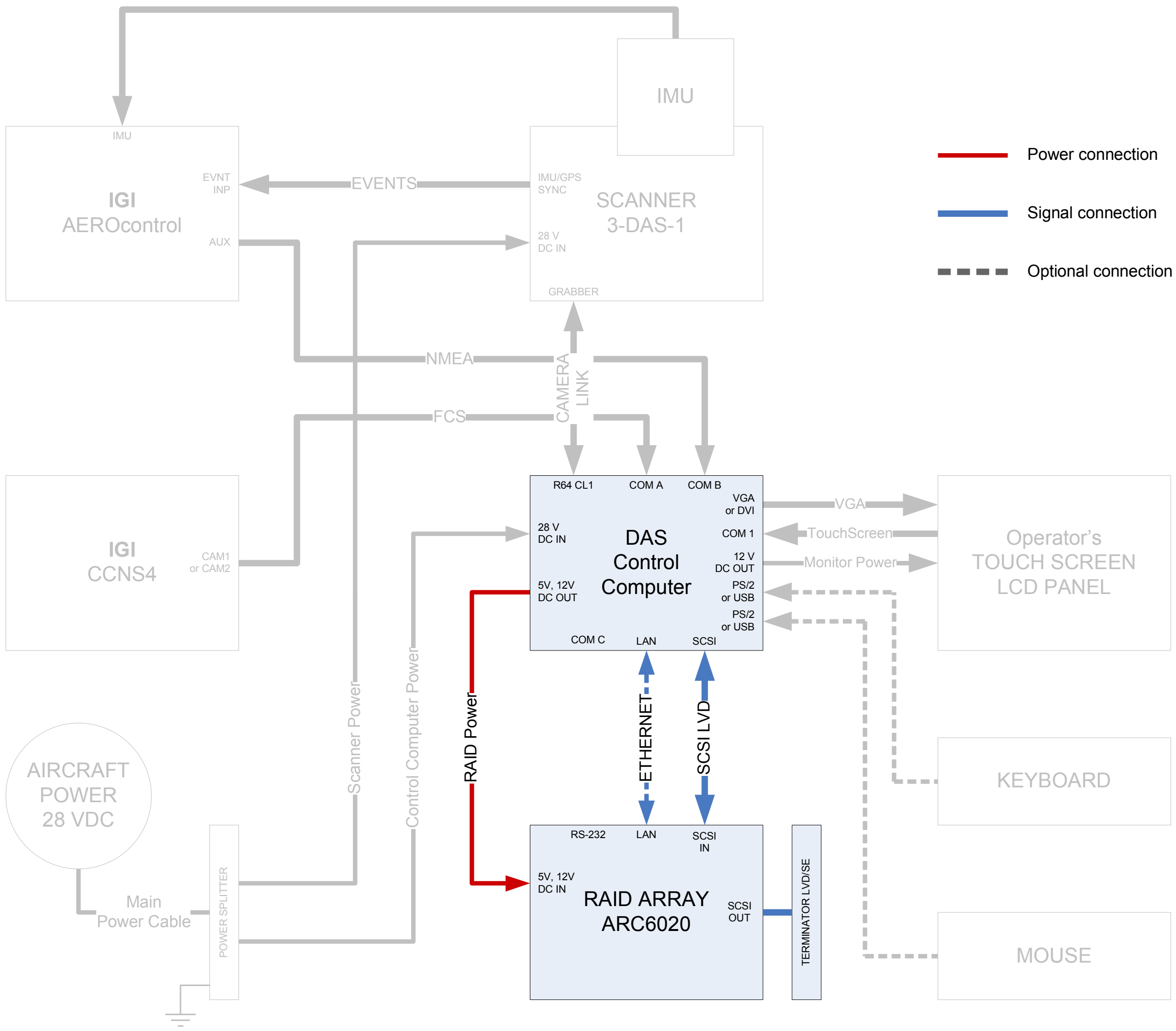


Figure 1.12: RAID-array connection.

General view of RAID-array back panel is shown in figure 1.13.

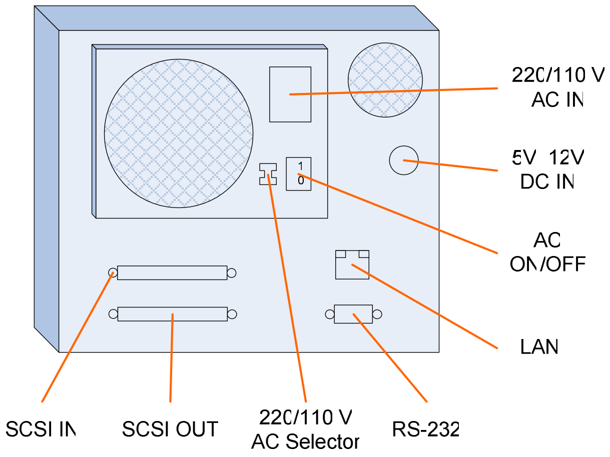


Figure 1.13: RAID-array, back view.

Step 5-3: Connection of scanner operator's console

- Connect VGA cable of display with control computer.
- Connect TouchScreen cable of display to COM1 port of control computer.
- Connect display power cable to "12V DC OUT" socket of control computer.
- Connect keyboard and mouse to control computer if required. (Figure 1.14)

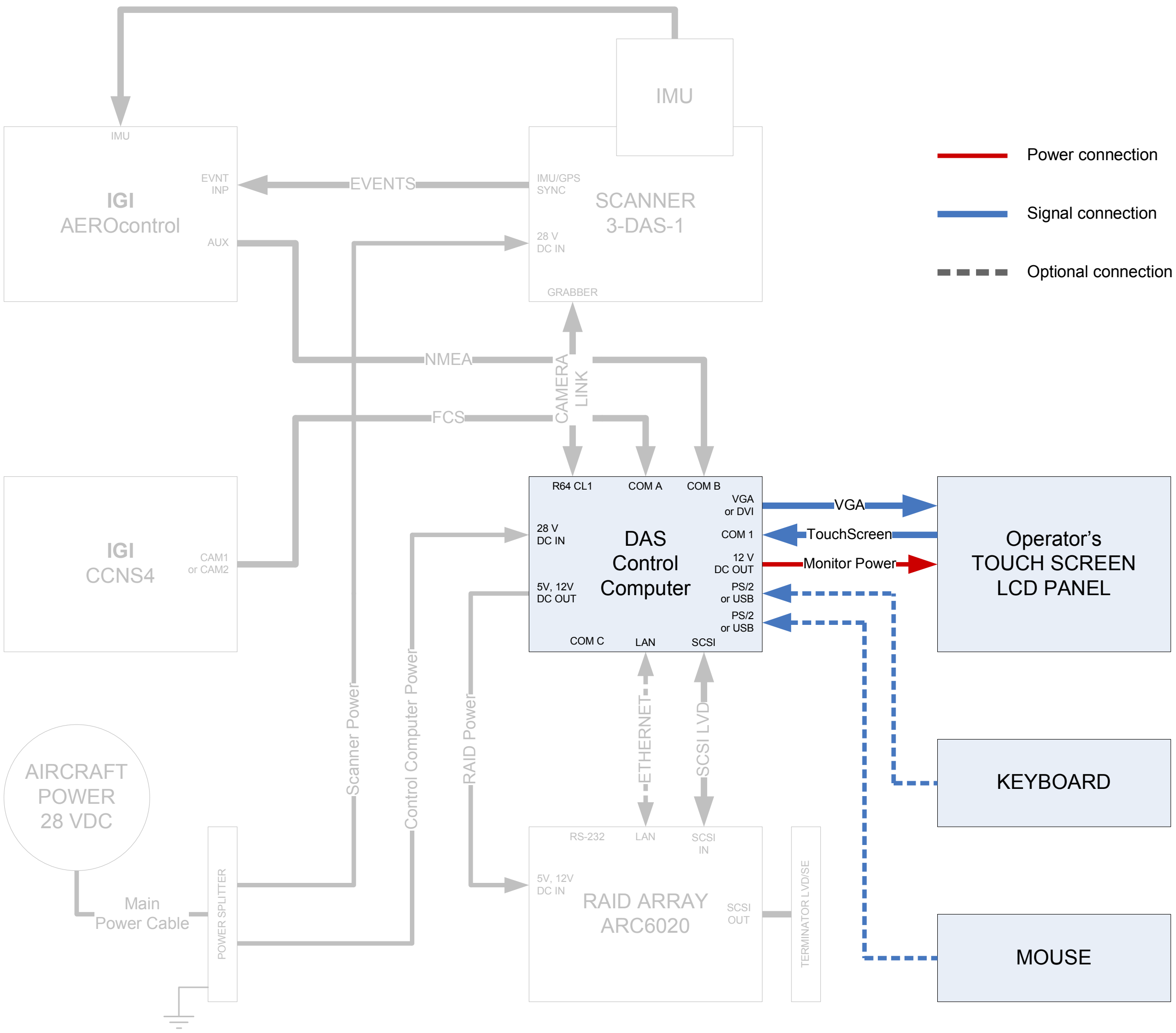


Figure 1.14: Connection of scanner operator's console.

Step 5-4: Scanner connection

- Connect GRABBER port of the scanner with R64 CL1 port of control computer via CAMERA LINK cable.
- Connect “IMU/GPS SYNC” output of the camera to “EVNT INP” input of POS AEROcontrol via EVENTS cable. (Figure 1.15)

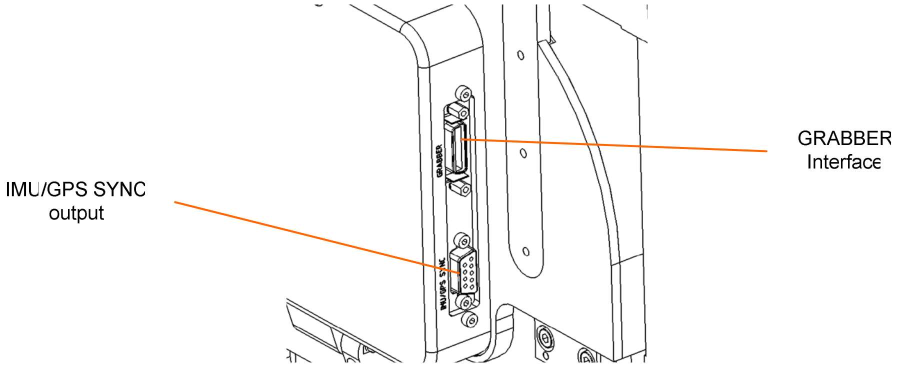


Figure 1.15: Scanner: GRABBER and IMU/GPS SYNC interfaces.

- Connect “Scanner Power” power cable to “28 V DC IN” input of the scanner. (Figure 1.16)

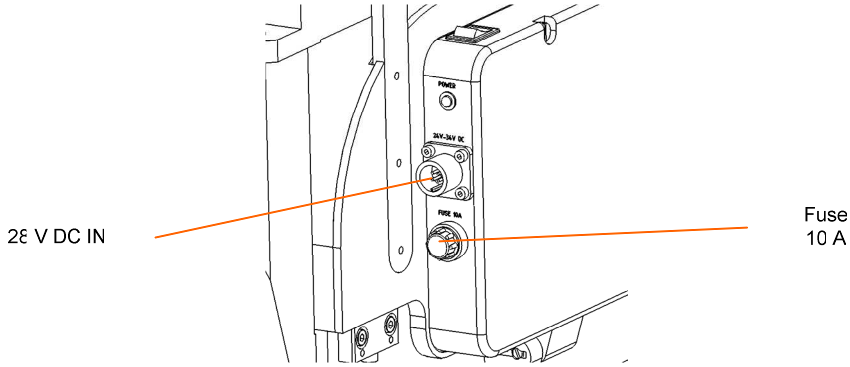


Figure 1.16: Scanner: power connector and fuse.

Scanner connection scheme is shown in figure 1.17.

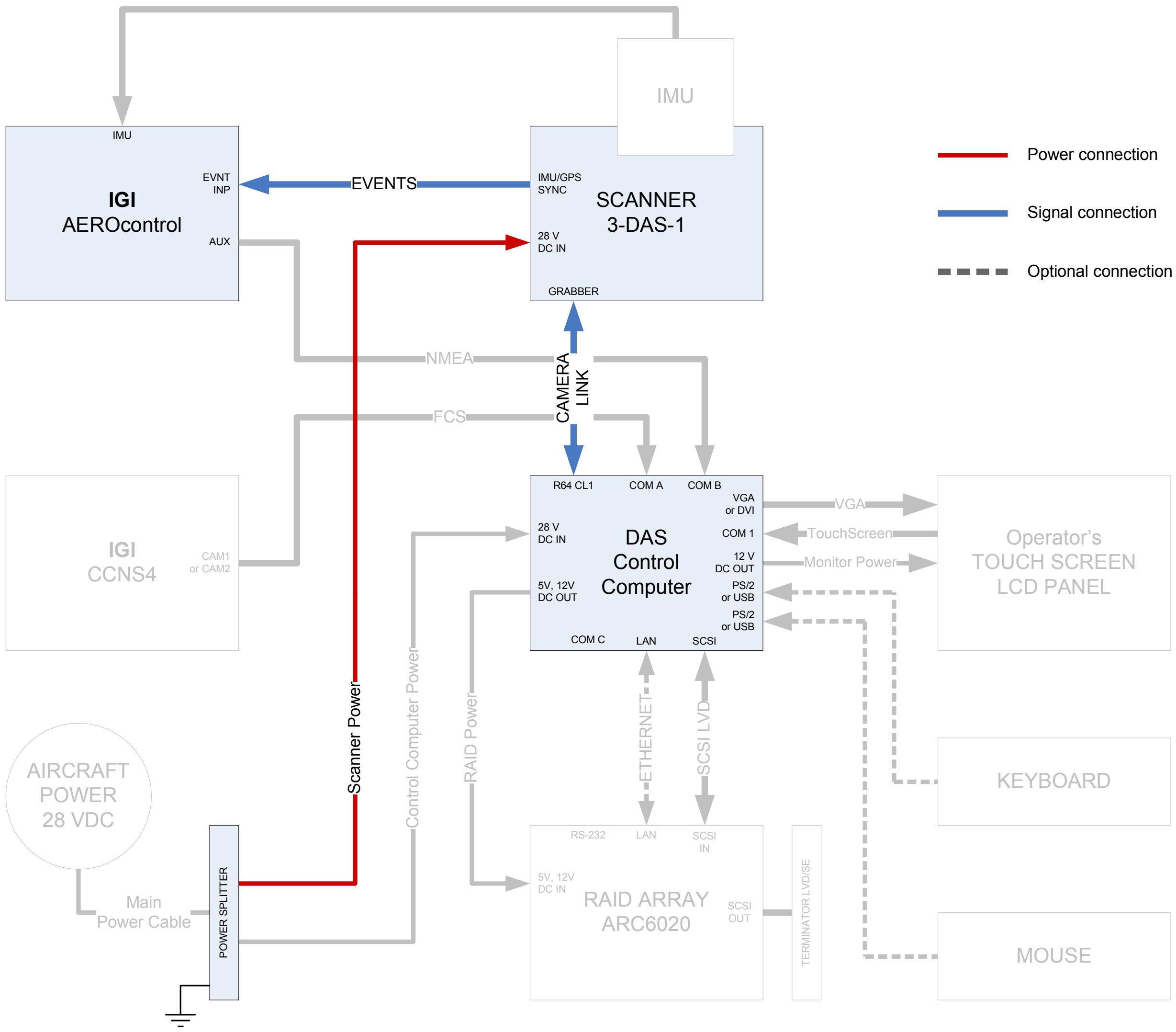


Figure 1.17: Scheme of 3-DAS-1 scanner connection.

Step 6 – Connection of Flight Management System laptop (optional)

If CCNS4 system component is not available for any reason you can connect portable computer (FMS laptop) with preinstalled specialized software as Flight Management System. For that please do the following:

Connect port AUX of AEROcontrol module, “COM A” and “COM B” ports of control computer and COM1 port of FMS laptop via “FCS/NMEA” cable. (Figure 1.18)

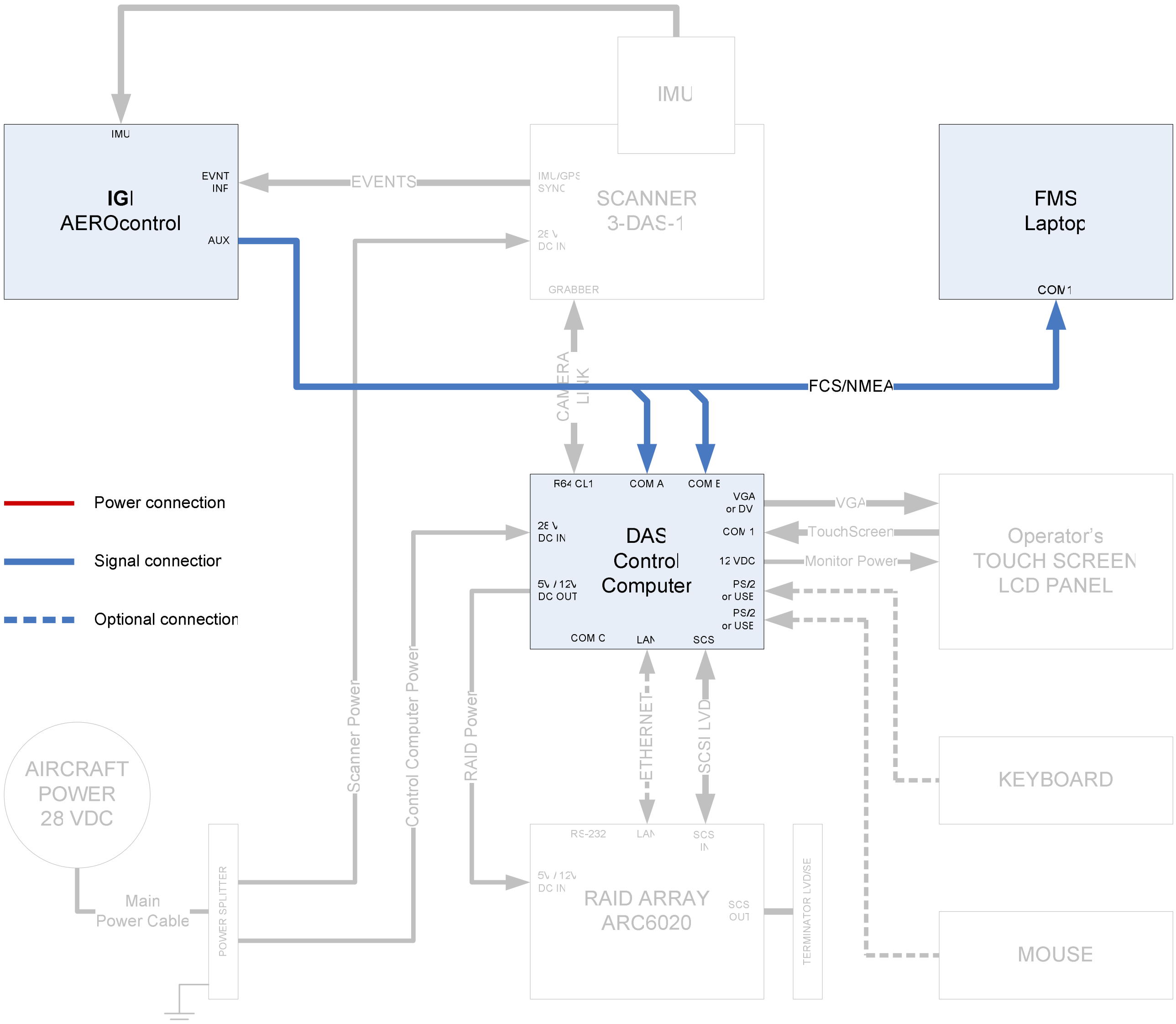


Figure 1.18: Connection of Flight Management System laptop.

- Connector marked “NMEA” connect with port “AUX” of AEROcontrol.
- Connector marked “COM A” connect with port “COM A” of control computer.
- Connector marked “COM B” connect with port “COM B” of control computer.
- Connector marked “FMS” connect with port “COM1” of FMS lptop .

1.2. Turning on sequence

AEROcontrol and CCNS4 systems are not products of SPE "Geosystem". Please refer to manufacturer to get installation manual.

- Move switch on the right side of the rack to position «1». (Figure 1.19)

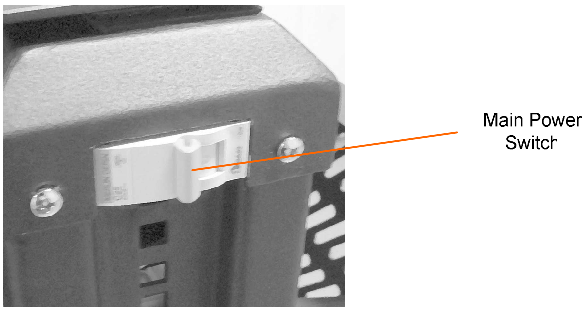


Figure 1.19: Main power switch.

- Turn on scanner, moving switch "Power" on its case to position «1» (Figure 1.20)

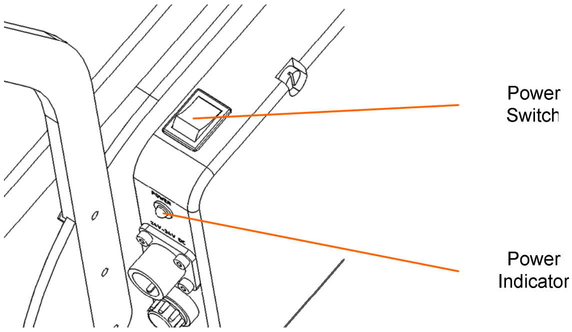


Figure 1.20: "Power" switch and indicator of the scanner.

"Power" indicator and 5 indicators of scanner internal voltages have to light up. (Figure 1.21)

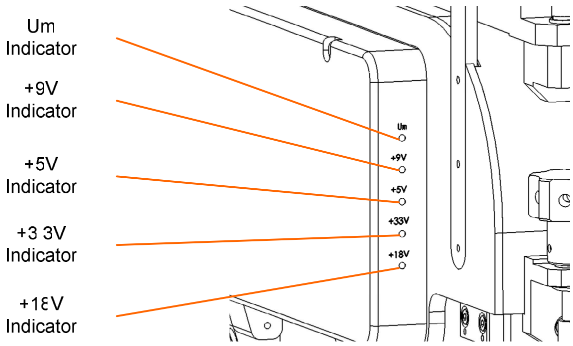


Figure 1.21: Indicators of scanner internal voltages.

- Open protective cover on control computer with computer case key and press "Power" button for a short time. (Figure 1.22)

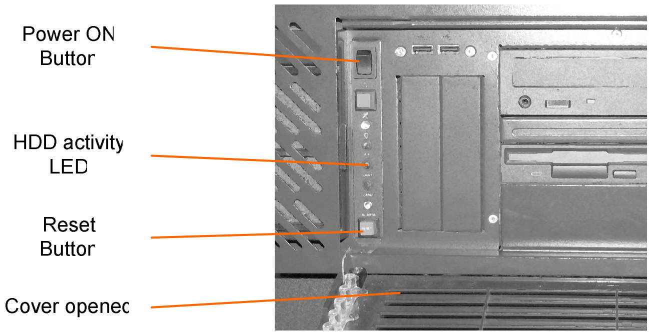


Figure 1.22: Cover in open state and “Power” button.

RAID-array and operator’s display will be switched on with control computer automatically.

- You can start working after OS loading complete.

1.3. Turning off sequence

AEROcontrol and CCNS4 systems are not products of SPE "Geosystem". Please refer to manufacturer to get installation manual.

Having finished mission:

- Turn off scanner, moving switch on its case to position «0». (Figure 1.20)
- Select "Turn off" item from "Start" menu on control computer and wait until OS will finish its work.

RAID-array and operator's display will be switched off with control computer automatically.

- Move switch on the rack to position «0» for board power disconnection. (Figure 1.19)

1.4. Transferring data to other computer

- Be sure that control computer is turned off.
- Release RAID-array in-out table, having unscrewed 2 fixing screws on front of the rack, and move it out up to the stop. (Figure 1.23)

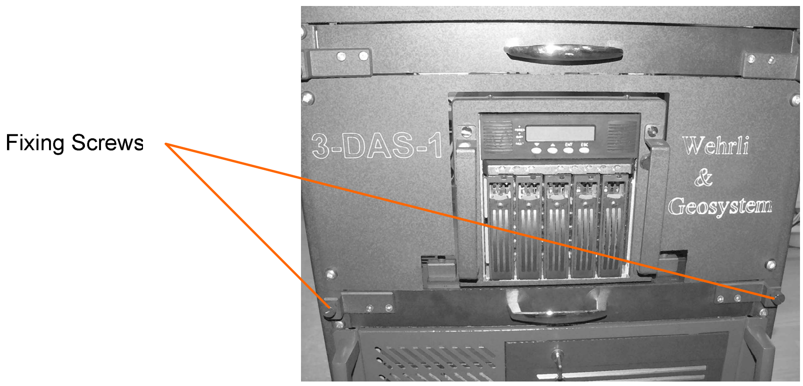


Figure 1.23: Fixing screws of the in-out table.

- Disconnect all cables on RAID-array back panel (i.e. SCSI cable, power cable and ETHERNET cable if connected).

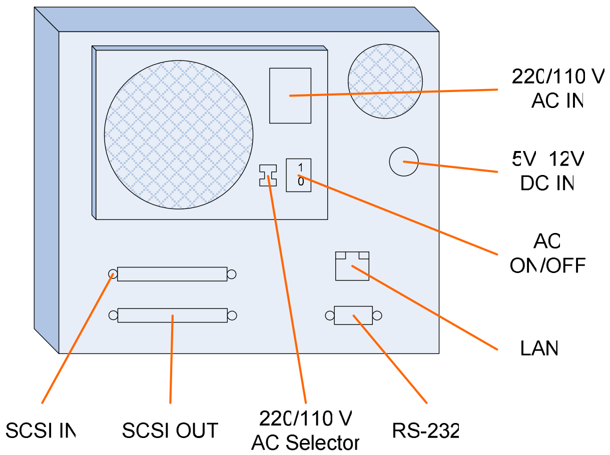


Figure 1.24: RAID-array, back view.

- Remove RAID-array from in-out table having unscrewed 4 fixing screws. (Figure 1.25)

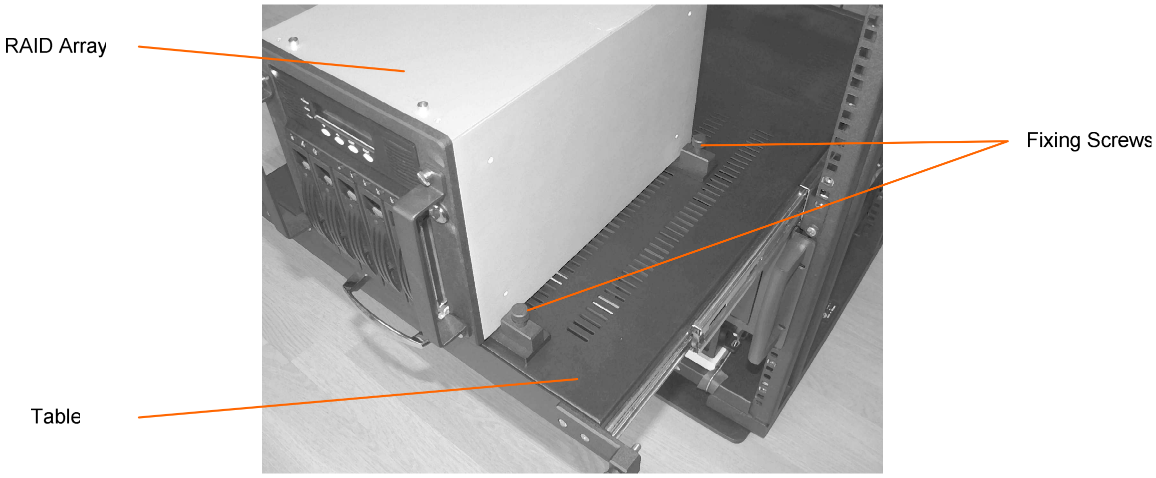


Figure 1.25: Removing RAID-array from in-out table of the rack.

To connect RAID-array to office computer you should have the next:

1) AC power cable with Euro or US plug according to socket type in your office (see list of components supplied);
2) Adapter for external SCSI-devices with drivers required (not supplied);
3) External SCSI-cable (it is analogue to component supplied).

If your cable has "Terminator" impedance matcher, you should remove terminator installed on "SCSI OUT" port of RAID-array.

- Put RAID-array on plane and solid surface.

- Place power loopback to “5V, 12V DC IN” connector of RAID-array. (Figure 1.26)

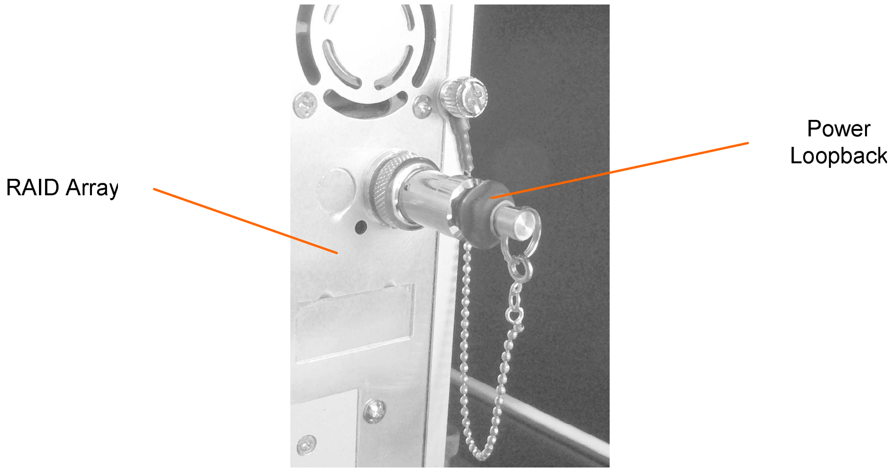


Figure 1.26: Power loopback in “5V, 12V DC IN” connector.

- Be sure that value set by switch on RAID-array back panel corresponds to voltage in AC network in your region. Both variants are possible: 110V or 220V (Figure 1.27)

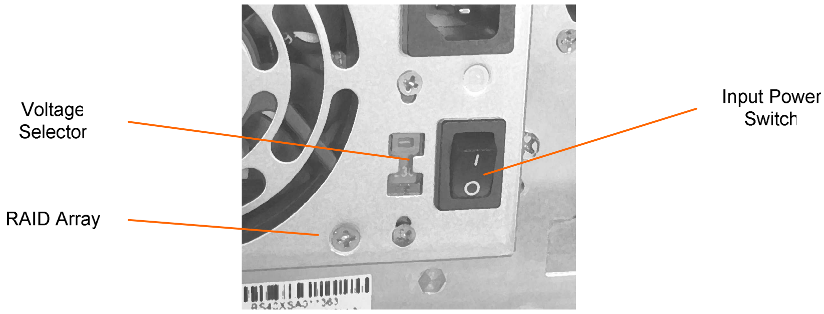


Figure 1.27: Back panel with voltage selector and input power switch.

Connection to AC network with incorrectly set voltage value can cause frozen-in damage of the RAID-array.

- Connect “SCSI IN” port of RAID-array with corresponding port of office computer.
- Connect RAID-array to AC power using AC power cable.
- Move switch on back panel of the RAID-array to position «1». (Figure 1.27)
- Turn on RAID-array by pressing “Power” button on front panel and wait for it’s initialization to be finished.

An IP address will be shown on LCD of the RAID-array when initialization complete.

- Turn on computer.

After OS loaded you can transfer data from RAID-array via copying.

Part 2. DAS software operation manual.

2.1. General information

DAS image recording and processing workflow is performed by set of specialized programs provided with the camera. The process is semiautomatic and requires minimum of user interference. It also involves usage of GPS/IMU post-processing software (***POSPack***, ***AEROoffice*** etc.). The workflow can be described by the following diagram:

Figure 2.1: DAS image workflow

Thus whole process can be divided into following steps:

1. Recording image (***DASControl*** software) and navigation data (Navigation software) (page 35)
2. Retrieving high accuracy trajectory and orientation (GPS/IMU post-processing software)
3. Extracting attitude for the each recorded strip (***POSExtract*** software) (page 36)
4. Creating calibration and LUT files (***DASCorrect*** software) (page 37)
5. Rectifying image (***DASRectify*** software)

To view raw image data use ***DASView*** software.
Review corresponding chapters for detailed description of each step.

2.2. Recording image with *DASControl* software

The main purpose of ***DASControl*** software is to set up camera and record image during flight mission. The program's interface is designed for use with touch screen; it allows to perform all necessary operations without keyboard and a mouse.

The program creates a project folder in "*YY-MM-DD_hh-mm-ss*" format to save all taken image data. This folder is used by ***DASCorrect*** and ***DASRectify*** software afterwards. Every new flight mission should be started within new project folder.

Following step by step instructions describe the software's principle of operation.

2.2.1. Preliminary preparation / before take-off

- Turn on the computer and the camera
- Check system operability: make sure the ***DASControl*** program is running with no warning messages.
- Select *Files* sheet

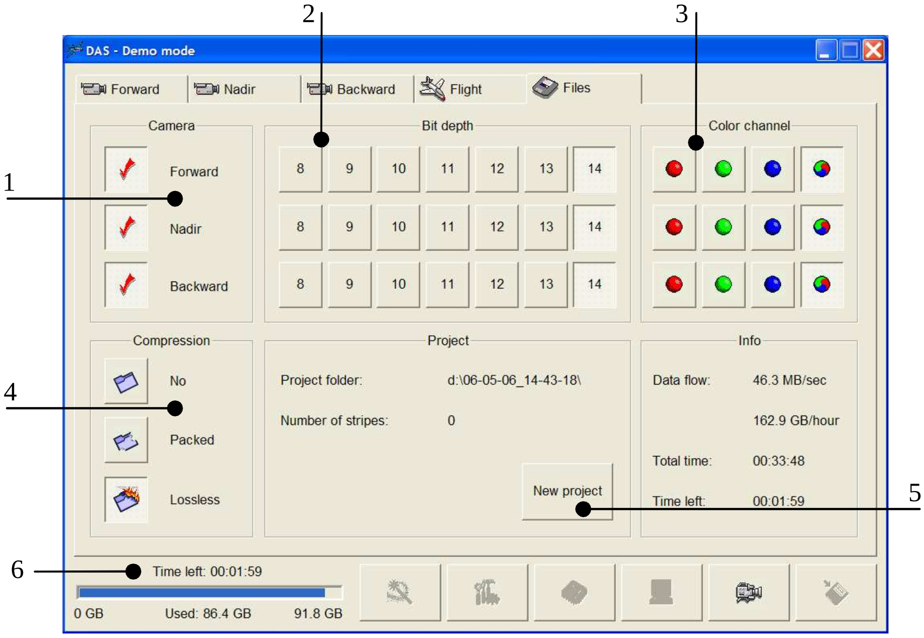


Figure 2.2: DASControl software, "Files" sheet

- Make sure the current settings are correct:
  - o Check all required cameras *(1)*
  - o Select preferred bit depth for each camera *(2)*
  - o Select required color channels *(3)*
  - o Select required compression method *(4)*
- Make sure RAID has enough free space for new mission data *(6)*
- Press *New project (5)* button to create new project folder.
- Turn off the computer.

It's highly recommended NOT to use RAID as storage for previous mission's data as well as any other information. It is advisable to start new mission with empty, formatted RAID to avoid data fragmentation since it cause speed degradation and stop writing the data.

It is highly recommended to take-off and land with turned off computer and RAID, since jerks can damage hard disks.

2.2.2. After take-off

- Please refer to corresponding manuals if you use POS system to initialize the system properly.
- Turn on the computer and the camera.
- Run ***DASControl*** program
- Press *Start grabbing* button *(7)*
- Switch to *Flight* sheet

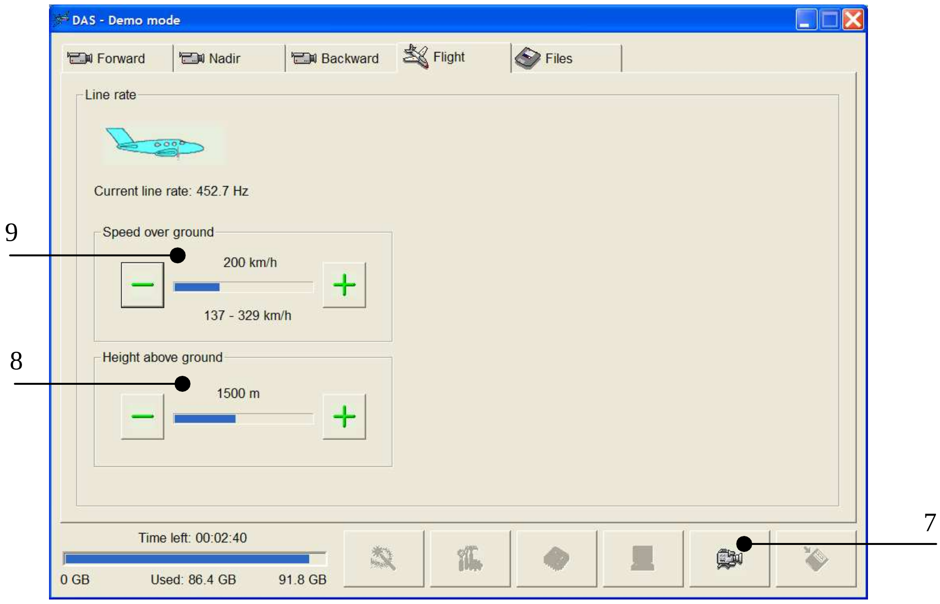


Figure 2.2: DASControl software, “Files” sheet

- Use “+” and “–” buttons to set scheduled altitude *(8)* and flight speed *(9)*

Values of altitude and speed are used to calculate appropriate scan line frequency. It is obviously that aircraft is unable to maintain constant values of its altitude and speed during flight line. Therefore the average altitude and the average speed should be set.

- Switch to one of camera’s sheets (*Forward*, *Nadir* or *Backward*)

Figure 2.3: DASControl software, camera sheet

- Press the *Autotune (8)* button to adjust video signal amplification. It will take some time to complete. Use “+” and “–” buttons *(9)* to adjust amplification manually. Changing it within current camera sheet will affect the rest cameras. Watch histogram and image waterfall. Amplification changes are reflected there immediately.

2.2.3. On the flight line

- When you are about to enter new flight line start image data recording by pressing *Start writing* button *(10).*
- When current flight line is finished, stop image data recording by pressing *Stop writing* button *(10)*.
- Note: if using the flight management system (FMS), it will start/stop data recording automatically.
- Repeat if necessary
- If flight mission consists of flight lines of different altitude and speed, switch to *Flight* sheet to adjust these values every time they change.

Changing altitude or speed values causes camera to change scan frequency and exposition time. Therefore it is necessary to adjust video signal amplification every time flight conditions are changed.

- When the last flight line is done, close program, turn off computer, RAID and camera before landing.

It is highly recommended to take-off and land with turned off computer and RAID, since jerks can damage hard disks.

2.3. Processing the navigation data with *POSExtract* software

Standard output of any navigation systems is represented by flight trajectory and orientation data for whole flight mission. The main purpose of ***POSExtract*** program is to extract useful navigation data which corresponds to recorded strips. It also interpolates navigation data to get 1 attitude record per each image line. ***POSExtract*** creates set of attitude files which are required for rectification process.

The program's interface is quite simple. It is represented by 3 fields to be filled by user:

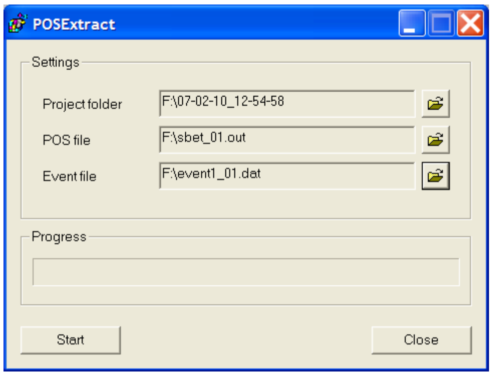


Figure 2.4: POSExtract software, main window

Press "Browse" buttons to select the following items:

- Project folder – the root folder created by ***DASControl*** software which contains all strip's images (for example "D:\07-06-25_13-00-00")
- POS file – the main navigation file created by navigation post-processing software
- Event file – file containing time stamps to synchronize image lines with navigation data.

Press "Start" to begin extraction. Usually it takes less then a minute to complete. The program will create set of "Strip.att" files, one in each strip folder (<Project folder>\<Strip_NN>\Strip.att). These files contain navigation information for corresponding strips.

2.4. Processing image with *DASCorrect* software

The ***DASControl*** software stores scanned image in raw format. That allows to preserve original 14-bit depth and gives possibility to pick the best parameters (like gamma, brightness, contrast etc) while post-processing. ***DASCorrect*** software chooses optimal radiometric parameters based on the statistic information. It also creates calibration files for dodging and CCD sensor uniformity.

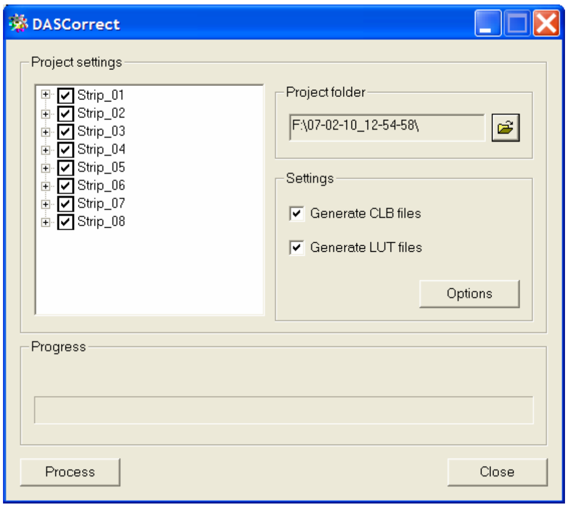


Figure 2.5: DASCorrect software, main window

Follow next steps to process a project:

- Press *Browse* button and select the root folder created by ***DASControl*** software containing all strip's images (for example "D:\07-06-25_13-00-00")
- Program will display all projects' strips. You can exclude some from processing if necessary. Uncheck corresponding checkbox to do this.
- Uncheck corresponding checkbox if you don't want to create calibration files (CLB) or look-up table files (LUT),.
- Press *Process* button to start. Processing time depends on project's size and HDD speed.

The program will create CLB and LUT files for each RAW file (*r.clb*, *r.lut*, *g.clb*, *g.lut*, *b.clb* and *b.lut*) in the same folder. These files will be used by ***DASRectify*** program.

2.5. Viewing image with *DASView* software

DASView software is a tool to view RAW image files of unlimited size. It also allows exporting defined image fragments and applying radiometric image correction in 16-bits per channel mode.

The following screenshot shows program's main window.

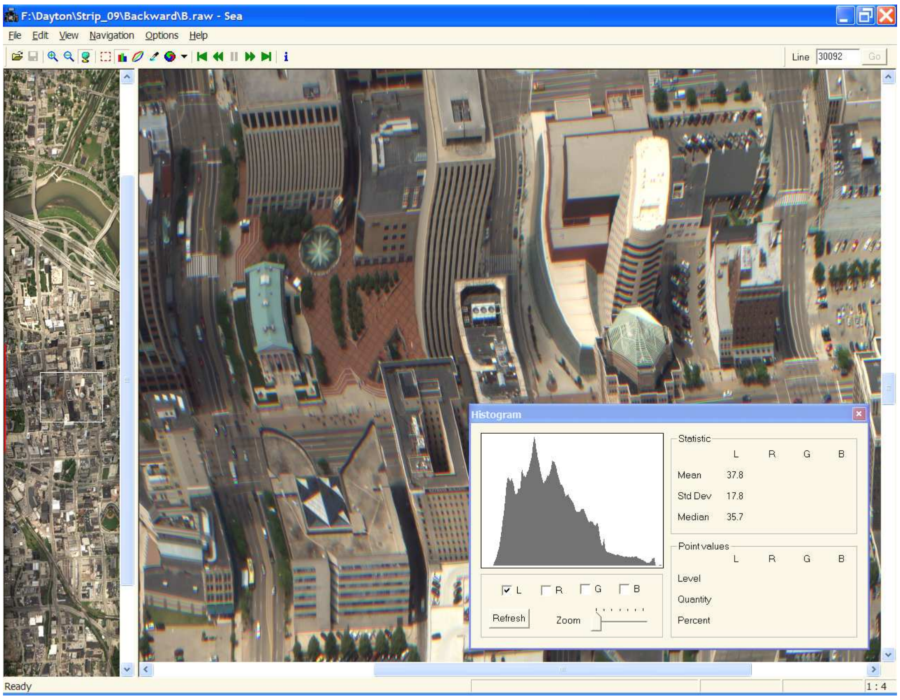


Figure 2.6: DASView software, main window

The thumbnail at the left edge of the window displays whole strip image and can be used for quick navigation.

Most of the program's functionalities (like navigation, zooming, selecting an area and exporting) are similar to common image viewer software. However, ***DASView*** uses slightly different way to apply radiometric correction. There is a set of standard modifiers that can be applied to the image. It includes *brightness*, *contrast*, *gamma*, *curve*, *equalize*, *level* and *logarithm*. Each of them (except *logarithm*) has its own parameters and can be adjusted manually. These modifiers do not update RAW image file; they affect currently displayed image only. Afterwards these modifiers are applied during rectification. It is possible to add as many modifiers as necessary; therefore it's important to define the order of applying. "Modifier stack" is used for these purposes. Modifiers will affect image in the order they was placed in stack.

Figure 2.7 describes main control elements for operating with modifier stack.

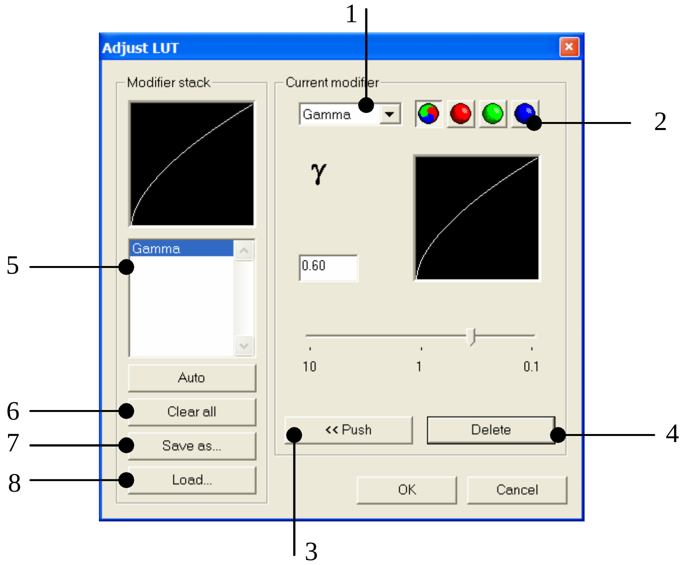


Figure 2.7: DASView software, “Adjust LUT” window

Select *Edit – Adjust LUT* from the main menu. The *Adjust LUT* window will appear. Select required modifier from the *Current modifier* list box *(1)* and color channel *(2)*. Set value for selected modifier (for example, *Gamma* = 0.6) and press *Push (3)* button to save the modifier in stack. One can add as many modifiers as necessary in that way. Once added to stack, any modifier is available for editing. Select required modifier in modifier list *(5)* to change its value. It can be removed by *Delete* (4) button if necessary. Press *Clear all (6)* button if you want to remove all modifiers from the stack. Use *Save as (7)* and *Load (8)* buttons to save or load current modifier stack.

In most cases modifier stack is created by ***DASCorrect*** program and does not need to be adjusted by user. However, it is possible to edit existing or create new, more appropriate stack. Press *Save as (7)* button while holding *Ctrl* key to generate new LUT-files based on current stack. LUT-files will be used by ***DASRectify*** software during rectification process.

Appendix A

A.1. 3-DAS-1 project structure.

Each separate 3-DAS-1 project is represented by one folder named in “YY-MM-DD_hh-mm-ss” format (for example “07-01-20_13-00-00”). This folder contains as many subfolders as flight lines in the flight mission, i.e. one subfolder for each strip. These subfolders are named “Strip_XX”, where XX – order number starting from 01. Thus, usual project have the following look:

- 07-01-20_13-00-00
  - Strip_01
  - Strip_02
  - Strip_03
  - Strip_04

Each “Strip…” folder contains 3 subfolders “Forward”, “Nadir” and “Backward” to save image from respective cameras. It also contains “Strip.att” and “Map.inf” files.

- 07-01-20_13-00-00
  - Strip_01
  - Strip_02
    - Forward
    - Nadir
    - Backward
    - Strip.att
    - Map.inf
  - Strip_03
  - Strip_04

Camera folders contain set of files with the same name and different extensions: “raw”, “inf”, “map”, “bbs”, “clb”, “lut”. This set is duplicated for each color channel: “R”, “G” and “B”. There is also one separate file named “Default.cc”

- 07-01-20_13-00-00
  - Strip_01
  - Strip_02
    - Forward
    - Nadir
      - R.raw
      - R.inf
      - R.map
      - R.bbs
      - R.clb
      - R.lut
      - …
      - Default.cc
    - Backward
    - Strip.att
    - Map.inf
  - Strip_03
  - Strip_04

A.2. Files description

Strip.att

This binary file represents navigation data for respective strip. It contains set of attitude structures; each structure corresponds to one image line. Number of records is not less than the number of saved image lines. Synchronization of attitude records and image lines is discussed in “x.inf” description. The attitude record has the following form:

```
// sizeof(TAttitudeRecord)= 6 * 8 = 48 bytes
struct TAttitudeRecord
{
  double
        latitude,
        longitude,
        altitude,
        roll,
        pitch,
        heading
};
```

Map.inf

This small ASCII file can be used to operate with “*.map” files. The following example describes file structure:

```
3                                     (current strip number)
166 2681                              (width and height of map image)
49.219090 28.580882 1177.60           (latitude, longitude and altitude of strip entry point)
49.231968 28.529308 1180.01           (latitude, longitude and altitude of strip exit point)
```

*.raw

Raw-files contain saved the image itself. File format depends on the used compression method. Read the corresponding “*.inf” file in order to find out compression method (or any other image related information). Only non-compressed file format is discussed below. Use specialized library to read packed or compressed file.

Non-compressed raw-file is a plain grayscale image, an array of pixel values without header. Each pixel is represented by 2-byte value and has value in range 0…16383.

For example, one can calculate size of a non-compressed raw-file with image width 8002 pixels and image height 10’000 pixels:

Size = Width * Height * BytesPerPixel = 8002 * 10’000 * 2 = 160’040’000 bytes

*.inf

This ASCII file contains all necessary information to process the corresponding raw-file. It have a standard format of “Ini” file for Microsoft Windows, so it can be accessed with Win-API functions like “GetPrivateProfileString()”. The following example gives some explanations of file fields meaning:

; Raw file information (v0.83)	
; GeoSystem (c) 2004	
; Original scan date: 29.10.2006 10:44:33	
[Image properties]	Image width, pixels
Width=8002	Image height, pixels
Height=43680	Significant bits per pixel
Color depth=14	Compression method (
Compression=0	0 – without compression,
	1 – packed
	2 – lossless compression)
	Physical pixel size, microns
Pixel size=9	Amplification, used during scanning
Amplification=+ 15.3 dB	
[Flight properties]	
Height above ground=900	0 – meters, 1 - feets
Height unit=0	
Speed over ground=180	0 – kmh, 1 - knots
Speed unit=0	Focal distance, mm
Focal distance=110	Angle, degrees
Camera angle=0	
Scale=8181.82	Ground pixel size, cm
Resolution=7.36	When 0, “map” file should be recreated
Map=1	
[Sync data]	*See below for “Sync data” description
First sync line=18	
Event number=1	
Event frequency divisor=72	

“*Sync data*” section is intended to synchronize image lines with attitude data.

“*First sync line*” – is only necessary parameter if using “*Strip.att*” file. To find the attitude record for a corresponding image line, use the following formula:

$$attitude\_record\_index = image\_line\_index + first\_sync\_line$$

For example, if “*First sync line*” parameter is 18, the first attitude record in “*Strip.att*” file should correspond to image line with index 18 (starting from zero).

The rest two parameters are necessary if you want to process raw navigation data by yourself.

“*Event number*” states for index of first event which corresponds current strip within the whole flight mission.

“*Event frequency divisor*” shows how many times line frequency is greater then event frequency. To obtain time value for each image line one should interpolate event time values.

***.map**

Map-file contains thumbnail of saved image for quick review and navigation with Sea.exe. Scale factor of thumbnail image is 48. Map-file is plain grayscale image, an array of pixel values without header. Each pixel is represented by 1-byte value and has value in range 0…255.

*.bbs

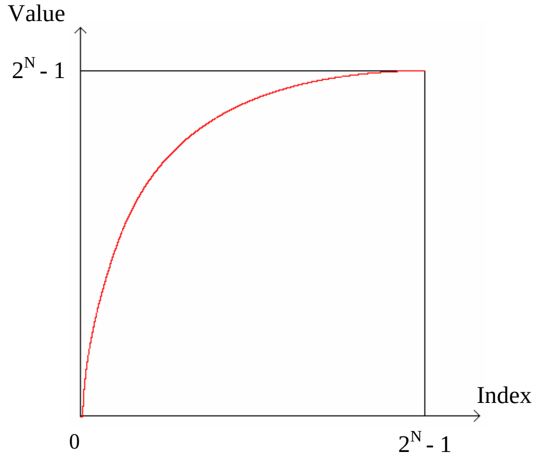
This file is present only if lossless compression is used. File is used by Sea.exe and DASImage library for quick access to compressed images and does not require to be processed by end-user.

*.clb

This is binary line sensor calibration file. It contains factors which are to be applied (multiplied) to CCD pixels. Each factor is represented by float value (4 bytes) not less then 1.0. Since file contains 1 value for each image line pixel, its size is always constant: 8002 pixels * 4 bytes = 32'008 bytes.

*.lut

Since raw-file is always store raw unadjusted image, lut-file is used for radiometric correction before displaying image. It contains lookup table for whole range of pixel brightness values. This binary file consists of 2^N values, where N – bit depth of an image (can be retrieved from inf-file). Each value is 2-bytes unsigned value within range $0 \ldots 2^N-1$.



Default.cc

This ANSI file is used to create corresponding LUT-files. It contains information concerning different color correction modifiers like brightness, contrast, gamma etc. Use Sea.exe to edit Default.cc and create LUT-files.

Appendix B

Detailed list of components

№	Name	Quantity
1	Digital airborne scanner 3-DAS-1	1
2	Mass-compensator	1
3	IMU adapter plate	1
4	Computer rack	1
5	DAS control computer	1
6	External RAID-controller ARC6020 with plug	1
7	400 GB HDD	5
8	LCD-monitor AEGIS with TouchScreen panel	1
9	USB keypad compatible with OS Windows	1
10	USB mouse compatible with OS Windows	1
11	FMS Laptop stand	1
12	Computer case key	2
13	Camera Link cable	1
14	FCS/NMEA cable	1
15	FCS cable	1
16	NMEA cable	1
17	SCSI LVD exterior cable	1
18	ETHERNET cable	1
19	Scanner Power cable	1
20	Control Computer Power cable	1
21	RAID Power cable	1
22	Adapter of monitor power RA9000XC1594	1
23	Main Power cable	1
24	AC power cable with EURO plug	1
25	AC power cable with US plug	1
26	DB9M connector with DP-9CC cover	1
27	LVD/SE terminator	1
28	10 A fuse	10
29	Scanner specification	1
30	Calibration Certificate	1
31	User’s manual for AEGIS monitor	1
32	This user’s manual	1